REMARKS

Reconsideration and allowance of the pending claims in the application are requested.

Claims 1-8 and 10-22 are pending in the case.

Claim 22 is allowed over the cited art. Claims 10 and 11 are objected to, but would be allowable if rewritten in independent form including all of the limitations of claim 22, the base claim, and any intervening claims.

Claims 1-8, 12-21 have been rejected under 35 USC 103 (a) as unpatentable over USP 5,787,123 to T. Okada et al, issued July 28, 1998, filed October 25, 1996 (Okada) in view of USP 5,812,523 to M. Isaksson et al, issued September 22, 1998, filed March 30, 1995 , Isaksson of record.

USP 6,356,555 to S. Rakib has been cited of record, but not relied upon.

Claim 10 has been canceled and combined with claim 22, as New Claim 23, which places claim 23 in condition for allowance. . Claim 11 has been amended to depend upon New Claim 23, which places claim 11 in condition for allowance.

Before responding to the rejection, applicants would like to distinguish Okada and Isaksson from the present invention (Cupo), as follows:

1. Okada:

Okada discloses an OFDM receiver for receiving OFDM modulated signals. A demodulating means demodulates the received OFDM modulated signal into a baseband signal. A phase difference detecting means outputs a phase difference information between the phase of a carrier forming the demodulated OFDM signal and the phase of the carrier before one OFDM symbol. An adding means adds the phase difference information from the phase difference detecting means as many as a plurality of carriers and a reference signal generating means for generating the reference signal used for demodulation of the OFDM modulated signal based on an output from the adding means. Okada fails to disclose limitations of Cupo, as follows:

A. Okada fails to disclose computing the auto correlation value of I and Q components as a sample number in a baseband signal.

Okada reproduces the regenerated carrier from the mutual correlation of the receiving signal and reference signal and also to reproduce the clock from the channel impulse response of the reference symbol. Column 3, lines 55- 61. Specifically, demodulated I and Q data are inputted to a square circuit and to a multiplier which provides a phase error detecting signal fed to a local oscillator to regenerate the carrier. Col. 5, lines 14 – 41. In contrast, Cupo correlates the I and Q components of a received symbol at 544 sampling points in a baseband signal and averages the correlation values over the latest L frames and saving them as a sample number in an L deep FIFO. An estimated offset value is selected as the negative of the phase angle of the auto correlation function at the sample number, as described in the specification at page 4, lines 7 - 20. Okada fails to correlate the I and Q components at sample points and generate a sample number of a baseband signal for synchronization of the OFDM transmitter and receiver.

B. Okada fails to disclose using an averaging correlation function based on $\overline{R}_i = \sum_{j=1}^{L} R_i(j)$. to determine a frame boundary

Okada discloses a phase error signal corresponding to the carrier in the transmitting side and a phase error of the receiving side are supplied to a low pass filter to generate a control voltage for a local oscillator to regenerate the regenerated carrier. Col. 5, lines 30 – 41. In contrast, Cupo discloses using the amplitudes of an averaging correlation function to estimate a frame boundary. Page 7, lines 10 – 16. Okada fails to disclose using an average correlation function to determine a frame boundary in a baseband signal

C. Okada fails to disclose providing an offset value indicative of the phase difference between the receiver and a transmitter

Okada discloses a carrier regenerating circuit obtains all phase errors of the carriers assigned to the I and Q data as one OFDM symbol. A differential decoding circuit synchronizes

the frequency and phase of the regenerated carrier outputted from the local oscillator to those in the transmitting side. Column 10, lines 1 – 5. In contrast, Cupo discloses an estimated offset value is selected as the negative of the phase angle of the auto correlation function at a sample number. The offset value is applied to the frame stored in the two-deep FIFO. The value is identified by the sample number for correcting the time domain samples of the useful symbol period. The corrected samples are applied to the input of an FFT block and thence to a data demodulator. Page 4, lines 19 – 23. Okada fails to disclose generating an offset value for a frame in synchronizing an OFDM transmitter and receiver.

D. Okada fails to disclose using an auto correlation value as an input to a phase lock loop to correct for phase.

Okada discloses generating a phase error detecting signal to generate a control voltage of a local oscillator for carrier regeneration and the control voltage is fed back to the local oscillator to regenerate the regenerated carrier. Column 5, lines 37 – 42. In contrast, Cupo discloses generating auto correlation value as an input to a phase lock loop to correct for phase error. Page 8, line 25 continuing to page 9, line 6. Generating a control voltage for a local oscillator to regenerate a carrier does not disclose or suggest the carrier phase adjusting process of Cupo.

2. Isaksson:

Isaksson discloses a method of demultiplexing OFDM signals and a receiver for such signals. More particularly the method is concerned with synchronization in an OFDM receiver. A signal is read into a synchronization unit, in the time domain, i.e., before Fourier transforming the signal by means of an FFT processor. In the synchronization unit, a frame clock is derived for triggering the start of the FFT process and for controlling the rate at which data is supplied to the FFT processor. For OFDM reception, it is vital that the FFT process commences at the right point in time. Once the frame clock has been recovered, a frequency error can be estimated by the synchronization unit. The frequency error is used to control; an oscillator which generates a complex rotating vector which is, in turn, multiplied with the signal to compensate for frequency errors. The method can be used both with OFDM systems in which symbols are separated by

guard spaces, and with OFDM systems in which symbols are pulse shaped. Isaksson fails to disclose limitations of Cupo, as follows.

A. Isaksson fails to disclose a phase lock loop generating a sample number of a desired frame boundary.

Isaksson discloses a phase-lock loop producing a synchronized digitized OFDM signal for input to a FFT processor for demultiplexing a synchronized digitized OFDM signal. Isaksson fails to disclose a phase lock loop generating a sample number of a desired frame boundary for timing and frequency offset

Summarizing, Okada and Isaksson disclose a local oscillator in a receiver controlled on the basis of the phase error of a plurality of carriers among those forming an OFDM signal and a phase lock loop producing a synchronized OFDM signal. Okada and Isaksson, alone or in combination fail to disclose or suggest, determining an offset in a frame boundary using a correlation function to identify a sample number for synchronizing an OFDM transmitter and receiver. A worker skilled in the art has no disclosure or teaching describing an averaging correlation function generating a sample number correcting frequency and timing offset between an OFDM receiver and transmitter. The rejection of claims 1-8 and 12 – 21 under 35 USC 103 (a) fails for lack of support in the cited art.

Now turning to the rejection, applicants respond to the indicated Paragraphs of the Office Action, as follows:

<u>REGARDING PARAGRAPH 1 & 2</u>:

Claims 1-8, 12-21 disclose limitations, not disclosed in Okada in view of Isaksson, as follows:

A. <u>Claim 1</u>:

(i) "means for computing auto correlation amplitude and phase values of the I and Q components at sample points in the base band signal;"

Okada, at col. 3, line 58 and continuing to col. 4, line 4, describes correlating the receiving signal and reference symbol by forming a costas loop using the modulated output of a particular frequency of each OFDM symbol. The arithmetic result is fed back to a local oscillator for synchronization purposes. In contrast, Applicants disclose that the I and Q components of a received signal are sampled at 544 sampling points and averaged over the latest L frame. Pg. 3, lines 12-14. The mutual correlation value of the receiving signal and reference signal of Okada does not describe computing the auto correlation amplitude values of the I and Q components at sample points for determining a symbol offset value with respect to a frame boundary for synchronization purposes.

(ii) "means for averaging and saving the auto correlation values of the I and Q components of the baseband signal over L symbols for two or more frames before computing the correlation;"

Okada, at col. 5, lines 20-41, describes square circuits for the "I" data and "Q" data supplying an output to a subtractor. The subtractor subtracts the two signals inputted and outputs the results to a multiplier which indicates a phase error detecting signal corresponding to the carrier in the transmitter. The phase error signal is supplied to a low pass filter to generate a control voltage to a local oscillator to regenerate a regenerated carrier for synchronization purposes. In contrast, Applicants disclose, at pg. 4, lines 13 - 17, the correlation values are averaged over the latest "L" frames and saved in an L deep FIFO. The amplitude and phase of the symbols are computed and passed to an offset estimator and an OFDM frame synchronization estimator for transmitter and receiver synchronization.

Okada, at col. 5, line 40-48, describes square circuits which square the I data and Q data and supply the outputs to a subtractor, for purposes of determining a phase detecting signal. Again, Okada does not describe providing a sample number indicating an OFDM frame boundary for synchronization.

(iii) "phase lock loop means for providing a sample number indicating an OFDM frame boundary using the averaged I and Q auto correlation values based on

$\overline{R}_i = \sum_{j=1}^{L} R_i(j)$. where: R_i is the average auto correlation value; L is the latest frame; $R_i(j)$ is the auto correlation value of the j-th frame and an output signal locked to the transmitter RF signal;"

Okada at column 10, lines 22-41, 65-67 describes the signal processing executed by the carrier regenerating circuit. When the regenerated carrier is not matched with the carrier in the transmitting side, the phase error is fed back to the local oscillator to regenerate the regenerated carrier for synchronization purposes. Applicants can not find any disclosure in Okada using the averaged I and Q auto correlation values based on $\overline{R}_i = \sum_{j=1}^{L} R_i(j)$. providing a sample number indicating an OFDM frame boundary for transmitter and receiver synchronization purposes.

(iv) "means providing a receiver clock chain output phase locked to the transmitter RF signal;"

Okada, at col. 4, lines 9-13, describes a costas loop for regenerating the regenerated carrier and clock signals. The regenerated carrier and clock control the local oscillator and clock and do not describe locking the receiver clock to the transmitter clock.

(v) "means providing an offset value indicative of the phase difference between the receiver and a transmitter; and"

Okada, col. 10, lines 24-59, describes a carrier regenerating circuit and a differential decoding circuit, which calculate a phase difference between the phases of the carrier forming an OFDM symbol. The phase error of the of the carrier assigned to the symbol increases in proportion to the frequency. The phase error is fed back to the local oscillator to regenerate the regenerated carrier or clock. Okada fails to describe calculating an offset value for a symbol.

(vi) "means for correcting frequency and timing offset between the receiver and the transmitter in the sample number."

Okada, at col. 12, line 25-40, describes the phase error are generated by mismatching of the clocks and does not describe correcting the frequency and timing between the receiver and the transmitter in a sample number.

Summarizing, Okada fails to disclose limitations of (i)... (vi). Isaksson does not supply the missing limitations. Isaksson discloses a phase-lock loop producing a synchronized digitized OFDM signal for input to a FFT processor for demultiplexing a synchronized digitized OFDM signal and fails to disclose a phase lock loop generating a sample number of a desired frame boundary for timing and frequency offset. In any case, Okada already disclose a phase lock loop in the form of a costas loop. The addition of the Isaksson loop would be inconsistent with the signal processing method of Okada. Without a disclosure in Okada and Isaksson relating to limitations (i) ... (vi), there is no basis for a worker skilled in the art to implement claim 1. The rejection of claim 1 under 35 USC 103(a) fails for lack of support in the prior art. Withdrawal of the rejection and allowance of claim 1 are requested.

B. Claim 12:

(i) "computing auto-correlation amplitude and phase values of the I and Q components based on $\overline{R_i} = \sum_{j=1}^{L} R_i(j)$. where: R_i is the average auto correlation value; L is the latest frame; R_i (j) is the auto correlation value of the j-th frame;"

Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to computing the auto correlation value of the j-th frame.

(iii) "estimating a frame boundary of the received signal;"

Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to estimating a frame boundary of the received signal.

(iv) "providing a sample number indicating a correct frame boundary;"

Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to providing a sample number indicating a frame boundary.

(v) "estimating frequency and timing offset in the sample number of the receiver and a transmitter; and"

Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to estimating the offset sample number of the receiver and the transmitter.

(vi) "correcting the frequency and timing offset in the sample number."

Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to correcting the frequency and timing offset of the sample number.

Summarizing, Claim 12 is patentable over Okada and Isaksson for the same reasons indicated in connection with the consideration of Claim 1 plus the additional features of (a) estimating a frame boundary and (b) providing a sample number indicating a correct frame number. Without such disclosure or teaching, a worker skilled in the art has no basis for implementing claim 12. The rejection of claim 12 under 35 USC 103 (a) fails for lack of support in the prior art.

C. Claims 21:

(i) computing auto-correlation amplitude and phase values of the I and Q components for two or more frames based on $\overline{R}_i = \sum_{j=1}^{L} R_i(j)$. where: R_i is the average auto correlation value; L is the latest frame; R_i (j) is the auto correlation value of the j-th frame;

Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to computing an average correlation value of the I and Q components over two or more frames.

(ii) estimating a frame boundary of the received signal;

Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to estimating a frame boundary of the received signal.

(iii) providing a sample number indicating a correct frame boundary using a phase lock loop;

Okada disclose a costas loop for regenerating a regenerated carrier. Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to providing a correct frame boundary using a phase lock loop.

(iv) providing a receiver clock chain output phase locked to a transmitter;

Okada at column 4, lines 9-13 discloses carrier regeneration of each OFDM symbol and their arithmetic result is fed to the clock generator for clock synchronization purposes. Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to providing a receiver clock chain output phase locked to a transmitter;

(v) estimating the transmitter and receiver frequency and timing offset in the sample number; and

Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to estimating the transmitter and receiver frequency and timing offset in the sample number.

(vi) correcting the frequency and timing offset in the sample number.

Cupo can find no disclosure, nor has the Examiner indicated in the references any disclosure relating to correcting the frequency and timing offset in a sample number.

Summarizing, Claim 21 is patentable over Okada and Isaksson for the same reasons indicated in connection with the consideration of Claim 1 plus the additional features of (a) estimating a frame boundary; (b) providing a sample number indicating a correct frame number, and (c) estimating the transmitter and receiver frequency and timing offset in the sample number. Without such disclosure or teaching, a worker skilled in the art has no basis for implementing claim 21. The rejection of claim 21 under 35 USC 103 (a) fails for lack of support in the prior art.

D. Claims 2 and 13:

(i) "means for estimating frame synchronization of the OFDM frame boundary."

Okada at column 2, lines 55 – 67 describes I and Q signals are inputted to buffer memories. The guard interval is added of the stored signals. Cupo can find no disclosure in the citation of estimating the synchronization of the frame boundary

E. Claim 3:

(i) "means for phase locking the transmitter and the receiver."

Claim 3 depends upon claim 1 and is patentable on the same basis.

F. Claim 15:

(ii) "applying the estimated frame boundary to a phase-locked loop.

Cupo can find no disclosure, nor has the Examiner provided any disclosure relating to applying an estimated frame boundary to a phase locked loop. In any case claim 15 further limits claim 12 and is patentable on its own merit.

G. Claim 16:

(i) "generating a coherent phase clock signal for the transmitter and the receiver. "

Claim 16 is patentable on the same basis as claim 12 from which it depends.

H. Claim 4:

(i) "means for estimating the transmitter and receiver frame offset."

Cupo can find no disclosure in Okada, nor has the Examiner cited any disclosure for estimating frame offset. Okada describes a different method than Cupo in synchronizing an OFDM transmitter and receiver.

I. Claims 5 and 14:

(i) "means responsive to the sample number and a negative phase angle of the auto correlation values for correcting for frequency synchronization, frame synchronization, and transmitter/receiver frequency offset.

Cupo can find no disclosure, nor has the Examiner cited any disclosure relating to correcting frame synchronization, frequency synchronization and transmitter/receiver offset using the negative phase angle of auto correlation values.

J. Claim 6:

Claim 6 is patentable on the same basis as claim 1 from which it depends.

K. Claims 7 and 17:

(i) "storing the I and Q component values; providing the stored I and Q values for auto-correlation; and providing the stored values for offset correction."

Okada at column 10, lines 24-59; column 11, lines 42-43; column 12, lines 38-40 and column 13, lines 10 -13 describes the principles of the processings executed by the carrier regenerating circuit and the clock regenerating circuit; the carrier can be regenerated with the transmitting side by feeding back the total value of the phase mismatch to the local oscillator; the clock and carrier matching with those in the transmitting side can be regenerated using the clock /carrier regenerating circuit in place of the carrier regenerating circuit and the clock regenerating circuit. Okada fails to disclose providing I and Q values for auto correlation and storing the values for offset correction

L. Claims 8 and 18:

(i) "storing the auto correlation values; providing the auto-correlation values to a frame estimator; providing the auto-correlation values to an offset estimator."

Okada describes a phase difference detecting means for correcting transmitter/recover synchronization in an OFDM receiver. In contrast, Cupo describes an OFDM

receiver providing frame synchronization and timing and data recovery in the presence of timing and frequency offset using auto correlation. Cupo can find no basis for including an offset estimator and frame synchronization estimator in Okada which is based on phase difference detection using carrier and clock regeneration circuits.

M. Claim 19:

(i) "adjusting the phase angle of each sample in a storing means by an amount proportional to "n" where "n" is counted from a correct frame boundary."

Okada describes altering the phase of a local oscillator to synchronize an OFDM transmitter and receiver. There is no disclosure in Okada relating to adjusting a sample in a frame relative to a boundary to achieve synchronization of an OFDM transmitter and receiver.

N. Claim 20:

(i) "averaging the auto-correlation values over frames in a storage device. "

Okada describes, when both regenerated carrier and clock are not matched with that in the transmitting side, the phase error E(n) of the nth carrier is expressed as a linear sum of the phase error then fed back to the local oscillator or clock generator to respectively regenerate the regenerated carrier or clock for correction purposes. Cupo can find no disclosure in Okada of averaging auto-correlation values over frames in storage to synchronize the OFDM transmitter and receiver.

Summarizing, Okada describes a phase detection system adjusting a local oscillator by phase differences in a carrier and clock to synchronize a OFDM transmitter and receiver. In contrast, Cupo discloses a frame offset method using auto correlation of samples to estimate transmitter and receiver frame offset for synchronization purposes. The apparatus and methods of Okada and Cupo are entirely different. There is no disclosure or teaching in Okada in view of Isaksson to implement claims 1-8 and 12-21 of Cupo. The rejection of claims 1-8 and 12 – 21 under 35 103 (a) fails for lack of support in the prior art.

CONSIDERATION OF CITED, BUT NOT APPLIED ART:

Applicants' attorney has reviewed and concludes USP 6,356,555 B1 to S. S. Rahib does not describe or suggest the limitations of claims 1 – 8 and 12 -21.

CONCLUSION:

Claim 10 has been canceled and combined with claim 22 as new claim 23. Claim 11 has been amended to depend upon claim 23. Claims 22, 23 and dependent claim 11 are allowable over the prior art. Claims 1-8 and 12 – 21 have been distinguished over the prior art based on the cited references describe different apparatus and method than the present invention for synchronizing an OFDM transmitter and receiver. The combination of Isaksson with Okada would conflict with the operation of Okada due to Okada already including a phase lock loop in the form of a costas loop. Entry of the amendment; allowance of claims 1-8 and 12 – 21, and passage to issue of the case are requested.

AUTHORIZATION:

The Commissioner is hereby authorized to charge any fees or insufficient fees or credit any payment or overpayment associated with this application to Deposit Account No. 13-4503, Order No. 3037-4167 CUPO-20-2.

Respectfully submitted,

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